Core Items Selection and Psychometric Properties of the Adult Attention-Deficit Hyperactivity Disorder Self-Report Scale-Chinese Short Version (ASRS-CSV)

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Abstract
Objective: This study aimed to develop and validate the Chinese Short Version of the Adult ADHD Self-Report Scale (ASRS-CSV), addressing the need for culturally appropriate diagnostic tools for Attention-Deficit Hyperactivity Disorder (ADHD) in the Chinese adult population.
Methods: Utilizing a combination of intergroup difference analysis, factor analysis, and network analysis, we identified core ADHD symptoms pertinent to the Chinese cultural context. The study involved two samples: a vocational and technical school sample (N=1144) and an internet sample (N=1654), comprising adults aged 16-25 years. Reliability, validity, and diagnostic efficacy of the ASRS-CSV were assessed through psychometric testing.
Results: The ASRS-CSV demonstrated high internal consistency (Cronbach's alpha > 0.9) and robust convergent validity (AVE > 0.7). The scale's diagnostic cutoff points were optimized, revealing high sensitivity and specificity for ADHD screening. Cross-cultural analysis highlighted differences in core ADHD symptoms between Chinese and Western populations, underscoring the scale's cultural sensitivity.
Conclusion: The ASRS-CSV is a reliable, valid, and efficient tool for screening ADHD in Chinese adults, reflecting the socio-cultural nuances of ADHD symptomatology. Its development marks a significant advancement in the field of psychiatry, offering a tailored approach for ADHD assessment in China and contributing to the global discourse on cross-cultural psychiatric diagnosis.

Keywords: ADHD, ASRS-CSV, psychometric validation, Chinese adult population, cross-cultural psychiatry.

Introduction

Attention-Deficit Hyperactivity Disorder (ADHD) is a common clinical disorder that begins in childhood and is characterized by persistent inattention, impulsivity, restlessness, and hyperactivity (Williams et al., 2023). The global prevalence of ADHD is approximately 5% (Cortese and Coghill, 2018), although it may vary between countries (Fayyad et al., 2017). Studies have shown that a large percentage of cases may persist into adolescence and adulthood (Caye et al., 2016), and a meta-analysis found that the prevalence of ADHD in adults aged 19-45 years was 2.5% (95% confidence interval 2.1-3.1) (Somma et al., 2019). The early onset of the disorder and its frequent co-occurrence with other psychiatric disorders mask the core symptoms of ADHD (Koyuncu et al., 2022 , Luderer et al., 2021 , Mucci et al., 2019 , Adamis et al., 2023 , Salvi et al., 2021), and adult recall of childhood symptoms may be biased, resulting in an underrecognized of this disorder, and may have a great potentially heavy impact on personal health and quality of life, burden on family and social.

The Adult ADHD Self-Report Scale (ASRS), is one of the most commonly used instruments for the assessment of ADHD in adults, contains 18 questions based on the DSM-IV criteria for adult ADHD symptoms and consists of two subscales, each containing 9 items (Kessler et al., 2005), of which 6 items were selected by stepwise logistic regression to form the ASRS short screener showed good internal consistency in both adult and adolescent samples (Kessler et al., 2007 , Sonnby et al., 2015 , Green et al., 2019). Due to its good reliability, the ASRS has been used in many countries (Somma et al., 2019 , Takeda et al., 2017 , Vňuková et al., 2022 , Pedrero Pérez and Puerta García, 2007 , Zohar and Konfortes, 2010 , Kim et al., 2013). However, we observed differences in the selection of core ADHD symptoms across different cultural contexts, such as disparities in the selection of core items related to attention deficit and hyperactivity/impulsivity between studies conducted in the United States and Japan (Kessler et al., 2005 , Takeda et al., 2017). This divergence may be due to differences in ethnic culture or different cultural expectations regarding

the expression of attention and impulsivity (Wernke and Huss, 2008). Therefore, although a translated version of the 6-item Chinese ASRS scale is currently available, revision of the scale based on the Chinese context is still needed. The reliability of the 18-item Chinese version of the ASRS scale has been validated in Taiwanese populations (Yeh et al., 2008), but it is important to note that there may be differences in semantic understanding among people from different geographical and cultural backgrounds. Meanwhile, in actual studies, reading a large number of words and answering many questions may be challenging for individuals with ADHD symptoms. And for large-scale population screening, concise scales are more appropriate. Based on the above, we believe that it is necessary to revise and simplify the Chinese version of the scale. In this study, we hypothesized that the core symptoms of ADHD may vary in different cultural contexts in China.

Scale simplification methods like intergroup difference analysis, factor analysis, and network analysis serve distinct purposes in understanding disorders. Intergroup difference analysis divides participants based on diagnostic criteria, highlighting prominent symptoms in specific groups(Wood et al., 2021). Factor analysis simplifies scales by uncovering underlying factors and item associations(Williams et al., 2010). Network analysis studies item relationships, presenting mental disorders as dynamic systems with interconnected factors. Central items, indicated by higher centrality indices, reflect core concepts within the network(Liang et al., 2023).

In summary, in this study, we will examine the core symptoms of ADHD as assessed by the ASRS using a Chinese sample. In order to ensure the robustness of the results, we will employ intergroup difference analysis, factor analysis, and network analysis simultaneously.

Method

Participants

Sample 1：A centralized sampling was conducted from September 2022 to May 2023 at a vocational and technical school in Changsha City, Hunan Province, China, where a sample of 1144 students were administered questionnaires on a class basis. The

subject students were introduced to obtain informed consent before completing the questionnaire, and 1144 questionnaires were distributed, and a total of 1144 valid questionnaires were collected. Among them, 624 (54.5%) were males and 520 (45.5%) were females. All participants were between 16 and 25 years old, the mean age of all subjects was (18.75±1.11) years.

Sample 2：The study was conducted on an Internet sample from June to October 2023, and participants' informed consent was obtained before questionnaires were filled out. There were a total of 1654 participants, including 822 (49.7%) males and 832 (50.3%) females, with an age range of 16-25 years and an average age of 19.02±2.01 years.

The study was approved by the Medical Ethics Committee of the Second Xiangya Hospital of Central South University.

Measurement

The ASRS (Adult ADHD Self-Report Scale) is an assessment tool designed for evaluating symptoms of adult Attention-Deficit Hyperactivity Disorder (ADHD). It consists of 18 items, divided into two parts: one section comprising 9 items for assessing inattention symptoms, and the other containing 9 items for evaluating hyperactivity-impulsivity symptoms. Each item presents five response options ranging from "never" to "almost always." Respondents select the option that best reflects their experiences over the past six months. The ASRS is a self-report questionnaire suitable for use in healthcare settings, educational institutions, and research studies. In this study, we collected data using the 18-item Chinese version of the ASRS, which has been validated for reliability. The overall Cronbach's alpha coefficient is 0.954, with a reliability of 0.926 for the inattention factor and 0.938 for the hyperactivity-impulsivity factor.

The Patient Health Questionnaire (PHQ-9& PHQ-2) are two of the most widely used screening tools for depression, assessing depressive symptoms over the past two weeks. Responses are rated on a 4-point Likert scale (0 = not at all, 1 = several days, 2 = more than 1 week, and 3 = nearly every day) (Kroenke et al., 2001). The PHQ-9 has 9 items to measure depressive symptoms and assess the severity of depression,

addresses all Diagnostic and Statistical Manual of Mental Disorders (DSM-5)-related symptoms, with scores ranging from 0-27(Negeri et al., 2021).The PHQ-2 includes the first two items of the PHQ-9 and assesses depressed mood and anhedonia, with scores ranging from 0 to 6(Levis et al., 2020). Both of the self-report scales show good reliability and validity in adolescents and adults(Anand et al., 2021). In this study, we tested the correlational validity of the scales before and after simplification using the above two versions of the scales, respectively. The Cronbach's alpha coefficient for the two scales in this study were 0.904 and 0.878.

The General Anxiety Disorder scale (GAD-7&GAD-2) are two concise self-report tools used to measure anxiety symptoms experienced during the past 2 weeks, each assessed on a 4-point Likert scale (0 = not at all, 1 = several days, 2 = more than 1 week, and 3 = nearly every day). The GAD-7 consists of 7 items that assess the frequency of anxiety-related symptoms over the past two weeks, with scores ranging from 0-21(Spitzer et al., 2006). The GAD-2 includes two items that assess the frequency of feeling nervous, anxious, or on edge and being unable to stop or control worrying, with scores ranging from 0 to 6, both of the two scales show good reliability and validity (Byrd-Bredbenner et al., 2021 , Skapinakis, 2007). As with the depression scale, the two versions of the scale were used in this study to test the correlational validity of the pre- and post-simplification scales. The Cronbach's alpha coefficient for the two scales in this study were 0.935 and 0.899.

Procedure

Step 1: Data cleaning and core symptom screening

In the initial data preparation and cleaning stage, we used SPSS 22.0 and employed a single quality control question (please select "strongly agree") for effective data screening. We also reported basic demographic variables such as age and gender.

Secondly, during the core item selection process, we utilized three methods all within JASP 16.0. The first method involved exploratory factor analysis. We employed a parallel analysis based on factor analysis (FA) with the Minimum residual method. Rotation was set to Oblique using the Bentler Q criterion, and we based the analysis

on the correlation matrix. In the output options, we selected to display only factor loadings greater than 0.4 and checked KMO test, Bartlett's test, Mardia's test, Structure matrix, Factor correlations, Additional fit indices, Residual matrix, and Parallel analysis. Factor loadings were presented in Structure Matrix form, illustrating the strength of the relationship between items and factors. Each element represented the strength of the correlation between the observed variable and the latent factor. We sorted them based on factor loading strength and selected three items. The second method involved network analysis. We chose EBICglasso in the operation panel and included centralities table in the output. To ensure robustness, we conducted 1000 bootstraps and selected "Case" as the sampling type. The items were ranked according to their centrality, and three items were chosen for each factor. The third method was intergroup difference analysis (independent samples t-test). We first divided all samples into high ADHD risk and low ADHD risk based on the suggested critical values for the 18-item complete version. Then, we performed difference testing between the two groups. For the location parameter, we selected a 95.0% confidence interval, used Cohen's d for effect size, and opted for the Brown-Forsythe option in Equality of variances, which is robust for non-normally distributed or outlier-prone data. The items were ranked by the absolute value of Cohen's d, and three items were chosen for each factor. In the ASRS-CSV and DSM-5 comparative analysis, we employed expert consultation and assessed inter-rater reliability using three metrics: Cohen's Unweighted Kappa , Fleiss' Kappa , and Krippendorff's Alpha values.

Step 2: Expert consultation

We separately invited ten psychiatrists from the Second Xiangya Hospital of Central South University to evaluate the content consistency of the two revised versions of the scale with the DSM-5 diagnostic criteria item by item, and to provide explanations of current problems and suggestions for modification, etc., as far as possible (See the attached materials for details).

Step 3: Psychometric testing of the short version of the scale

Thirdly, we conducted reliability and validity testing for the generated 6-item new scale, all using JASP 0.16. We employed correlation analysis to assess the relationship

between the 18-item complete version and the 6-item abbreviated version. We used confirmatory factor analysis, checking Additional fit measures, R-Squared, Average variance extracted (AVE), Heterotrait-monotrait ratio (HTMT), and Reliability. In the Multigroup CFA, we conducted gender invariance testing, using gender as the grouping variable, and performed tests sequentially, generating differences. All other settings were left as default. The flowchart of the study is as follows (Figure 1).

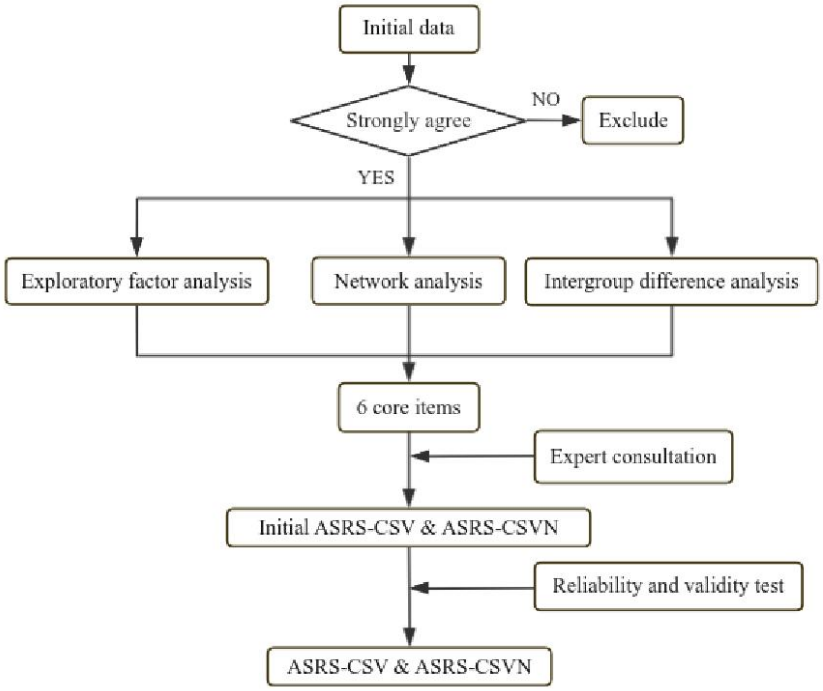


Figure 1 Research Flowchart

Results

Core symptom screening

Analysis of differences between groups

As per standard referencing, all participants were categorized into two groups (A score of 24 or higher is considered highly likely to have ADHD): the low-risk group (N=751) and the high-risk group (N=393). Group differences were examined across the 18 items, and the report includes means, standard deviations, t-values, p-values, and effect sizes (Cohen's d) for both groups (Table 1). The Cohen's d values were then ranked, and the results indicate that, from the perspective of group difference analysis,

the core items are item3, item6, item8, item12, item13, and item14.

Table 1 Descriptive statistical and differential significance tests

Item	M_0±SD	M_1±SD	*t*	*p*	**Cohen's *d***
1. *Careless mistakes*	1.60±0.699	2.80±0.674	-28.033	< .001[a]	-1.745
2. *Difficulty keeping attention*	1.63±0.777	2.95±0.653	-28.712	< .001[a]	-1.788
3. *Does not listen*[b]	1.47±0.660	2.69±0.721	-28.758	< .001	**-1.790**
4. *Does not follow through*	1.64±0.827	2.86±0.666	-25.182	< .001[a]	-1.568
5. *Difficulty organising*	1.94±1.083	3.00±0.627	-17.936	< .001[a]	-1.117
6. *Avoids effort*[b]	1.60±0.766	2.95±0.578	-30.605	< .001[a]	**-1.905**
7. *Loses things*	1.66±0.812	2.95±0.627	-27.500	< .001[a]	-1.712
8. *Easily distracted*[b]	1.64±0.788	2.98±0.593	-29.630	< .001[a]	**-1.845**
9. *Forgetful*	1.77±0.955	2.90±0.758	-20.408	< .001[a]	-1.271
10. *Fidgeting*	1.71±0.872	2.95±0.786	-23.732	< .001[a]	-1.478
11. *Leaves seat*	1.44±0.636	2.57±0.776	-26.352	< .001[a]	-1.641
12. *Feel restless*[b]	1.48±0.636	2.78±0.687	-32.035	< .001	**-1.994**
13. *Difficulty relaxing*[b]	1.44±0.650	2.66±0.783	-28.110	< .001[a]	**-1.750**
14. *On the go*[b]	1.38±0.589	2.65±0.705	-32.488	< .001[a]	**-2.023**
15. *Talks excessively*	1.50±0.683	2.64±0.747	-25.905	< .001	-1.613
16. *Rules conversation one-sidedly*	1.44±0.610	2.54±0.738	-26.945	< .001[a]	-1.678
17. *Difficulty waiting turn*	1.38±0.626	2.57±0.840	-26.917	< .001[a]	-1.676
18. *Interrupts others*	1.33±0.524	2.35±0.771	-26.315	< .001[a]	-1.638

Note. M_0 ± SD represents the mean and standard deviation of the low-risk group, similarly, M_1 represents the high-risk group.[a] Brown-Forsythe test is significant ($p<0.05$), suggesting a violation of the equal variance assumption.[b] represents the selected core items.

Factor analysis

The KMO test (MSA=0.961) and Bartlett's Test ($p<0.001$) results indicate that the scale is suitable for factor analysis. The results of the exploratory factor analysis (EFA) reveal that Factor 1 represents hyperactivity, Factor 2 represents executive difficulties, Factor 3 represents attention difficulties, and Factor 4 represents impulsivity (Table 2). To select the core items from the perspective of this method, the top three items from the two factors with the highest variance explained were chosen. Furthermore, we identified items that exhibit a higher correlation with the factors based on the Uniqueness index. According to this approach, the core items are item6, item7, item8, item12, item13, and item14 as per the factor analysis perspective.

Table 2 Factor loads in exploratory factor analysis

Item	Factor 1	Factor 2	Factor 3	Factor 4	Uniqueness
12[a]	**0.978**				**0.203**
14[a]	**0.856**				**0.210**
13[a]	**0.807**				**0.316**
11	0.593				0.379
10	0.554				0.480
7[a]		**0.958**			**0.238**
6[a]		**0.836**			**0.239**
8[a]		**0.759**			**0.277**
5		0.685			0.519
9		0.544			0.575
2			0.876		0.233
1			0.806		0.269
4			0.759		0.365
3			0.72		0.310
18				0.919	0.212
16				0.906	0.210
17				0.655	0.363
15				0.435	0.397
Proportion var.	0.203	0.183	0.15	0.142	

Note: Proportion var (variance proportion) indicates the proportion of total variance explained by each factor. It reflects the contribution of each factor to the total variance. Uniqueness represents the residual variance between the observed variable and the factor, i.e., the portion not explained by the factor. Lower Uniqueness values indicate a higher correlation between the variable and the factor. [a] represents the selected core items.

Network analysis

In network analysis, we reported four different centrality measures and presented the frequencies of core items selected based on different centrality measures (Table 3). Generally, when a network contains both positive and negative edges, there is a preference for selecting Expected Influence as the centrality measure. In cases where all edges in the network are positive, Strength is more often reported as the centrality measure. The results indicate that the core items selected by these two measures are consistent. In other words, item6, item7, item8, item12, item14, and item18 are the core items from the perspective of network analysis.

Table 3 Network node centrality

Item	Betweenness	Closeness	Strength	Expected influence	Frequency

1	-0.177	-1.389	0.453	**0.609**	1
2	-0.551	-1.473	0.294	0.445	0
3	**1.508**	-0.427	0.034	0.179	1
4	-0.364	-0.763	-0.379	-0.41	0
5	-0.551	-0.024	-1.085	-1.687	0
6[a]	**1.883**	**1.34**	**0.828**	**0.993**	**4**
7[a]	**0.01**	**1.173**	**0.527**	**0.685**	**4**
8[a]	-0.364	**0.886**	**0.629**	0.376	**2**
9	-1.113	-0.492	-1.745	-1.645	0
10	-0.739	0.666	-1.219	-1.105	0
11	0.385	**1.024**	0.057	-0.069	1
12[a]	**1.134**	**1.321**	**1.012**	**0.946**	**4**
13	**0.759**	0.799	-0.512	-0.381	1
14[a]	**1.321**	**0.911**	**1.693**	**1.65**	**4**
15	-0.739	-0.892	-1.336	-1.226	0
16	-1.675	-1.005	0.541	0.699	0
17	-1.113	-0.993	-1.169	-1.054	0
18[a]	0.385	-0.664	**1.377**	**0.996**	**2**

Note: Frequency refers to the ranking based on centrality, with the top three items with the highest centrality selected for each factor. 'a' represents the selected core items.

By combining the results of the three methods, we tentatively propose that item 6, item 7, item 8, item 12, item 13, and item 14 are the core items of the ASRS.

Psychometric testing of the preliminary version (ASRS-CSV)

Psychometric Testing

Based on the item selection results, we have named item 6, item 7, and item 8 as the Inattention factor and item 12, item 13, and item 14 as the Hyperactivity-Impulsivity factor. We conducted an examination of the psychometric properties of the newly generated short form scale.

Reliability

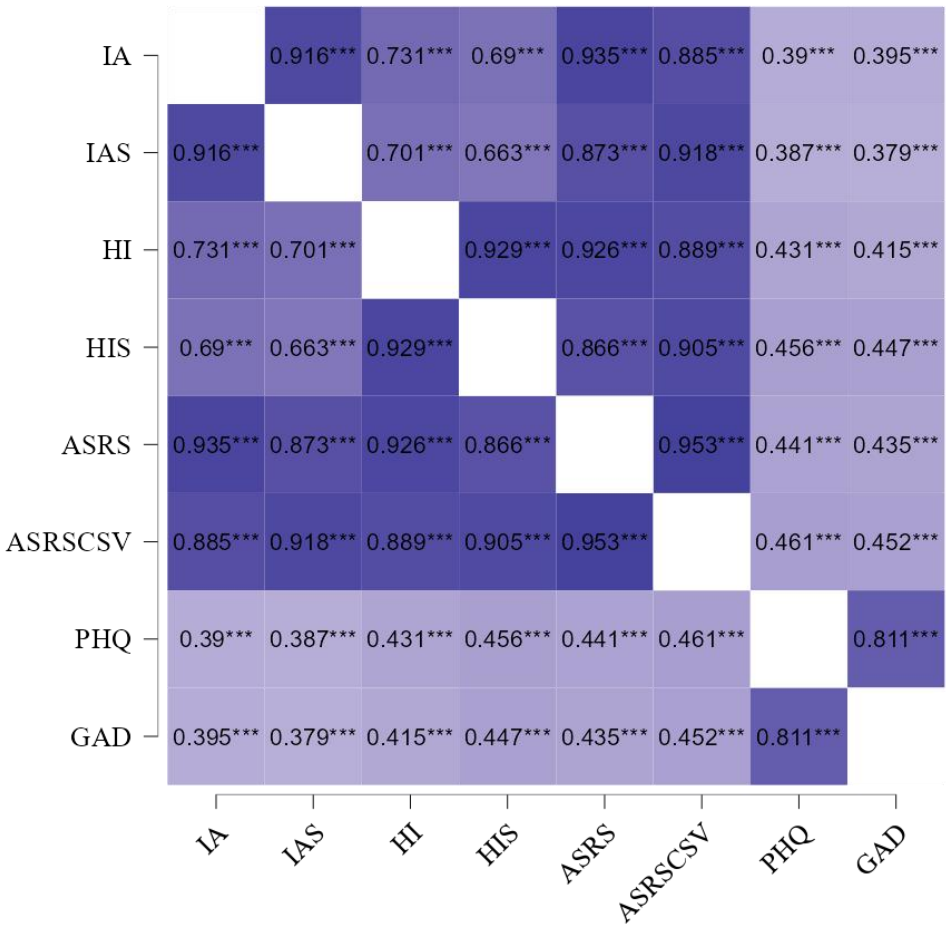
The Cronbach's α coefficients for each subscale as well as the total scale were found to be 0.903, 0.908, and 0.914, respectively. Additionally, the McDonald's ω coefficients for each subscale as well as the total scale were 0.904, 0.909, and 0.943, respectively. These results indicate that the scale and its internal factors all exhibit high levels of internal consistency reliability.

Validity

The Average Variance Extracted (AVE) value is utilized to assess convergent validity, which is computed by evaluating the variance contributed by indicator items (or observed variables) to their corresponding constructs. AVE values typically range between 0 and 1, with values exceeding 0.5 generally indicating good convergent validity. The AVE value for the Inattention factor is 0.757, and for the Hyperactivity-Impulsivity factor, it is 0.768, signifying that the scale exhibits strong convergent validity.

Concurrent validity involves evaluating the validity of a measurement tool by comparing its different versions or forms. It's essentially a form of measurement equivalence assessment. By comparing the correlations between these versions, it is possible to assess the validity of the abbreviated scale in measuring the same trait or construct. As shown in Figure 1, there is a high correlation ($r=0.953$, $p<0.001$) between the ASRS and ASRS-CSV and their factors, indicating a high level of concurrent validity.

We selected PHQ-9& PHQ-2 and GAD-7& GAD-2 for calibration association validity testing, considering the likelihood of comorbidity between ADHD and



depression and anxiety in clinical practice. Figure 2 demonstrates that both ASRS and ASRS-CSV exhibit moderate to strong associations with anxiety and depression ($r=0.435$-0.461, $p<0.001$), signifying good calibration association validity.

Figure 2 Correlation heatmap for the ASRS and its Chinese short version.

Note: IA represents the 9-item version for inattention, IAS is the 3-item version for inattention, HI represents the 9-item version for hyperactivity impulsivity, HIS is the 3-item version for hyperactivity impulsivity, and ASRS-CSV stands for the Adult Attention-Deficit Hyperactivity Disorder (ADHD) Self-Report Scale - Chinese Short Version (ASRS-CSV). In the heatmap, shades of blue indicate a positive correlation between two variables, with darker colors signifying a stronger degree of correlation.

Gender invariance testing

Measurement invariance, which means that the structural and metric properties of psychological measurement scales should remain consistent across different groups, time points, or measurement methods. In essence, it ensures that measurement results from a psychological scale are consistent and comparable under varying circumstances. Meaningful between-group comparisons can only be made when measurement invariance is established. Following the standards for invariance testing set forth by Chen and his colleagues, despite a reasonably substantial sample size in this study, uneven sample sizes between groups have led to the selection of relatively lenient criteria ($\Delta CFI \leq 0.01$; $\Delta RMSEA \leq 0.01$; $\Delta SRMR \leq 0.025$). In cases of conflicting criteria, changes in CFI are predominantly used as the primary criterion. The results indicate that ASRS-CSV demonstrates a high level of measurement invariance, specifically strict invariance, in both male and female samples (Table 4).

Table 4 Gender measurement invariance of ASRS-CSV

	$\chi^2(df)$	CFI	RMSEA	SRMR	ΔCFI	ΔRMSEA	ΔSRMR	Decision
Total	38.85(8)	0.994	0.059	0.015				
Male	47.86(8)	0.987	0.092	0.018				
Female	15.48(8)	0.996	0.043	0.017				
Configural Invariance	63.34(14)	0.990	0.080	0.018				
Metric Invariance	84.79(18)	0.987	0.082	0.032	0.003	0.002	0.014	Accept
Scalar Invariance	91.48(24)	0.987	0.071	0.033	0.000	-0.011	0.001	Accept
Strict Invariance	141.61(30)	0.978	0.082	0.030	0.009	0.011	-0.003	Accept

Expert correspondence on the applicability of the ASRS-CSV

Furthermore, we compared the six selected items with the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), which is the American psychiatric diagnostic manual used for diagnosing mental health disorders. This study compared the generated items with Part A of the DSM-5's diagnostic criteria for adult ADHD (Attention-Deficit Hyperactivity Disorder) and reported the correspondence between the core items and the diagnostic criteria (Table 5). We invited ten psychiatric doctors to assess the consistency between the diagnostic criteria and the items, with options of consistent, uncertain, and inconsistent. The expert panel has shown a high level of concordance between DSM-5 and ASRS-CSV, with 90% of the experts concurring that they exhibit congruence in their expressions. The Cohen's Unweighted Kappa (0.89), Fleiss' Kappa (0.75), and Krippendorff's alpha values (0.82) all indicate that the current round of expert consultation has yielded favorable inter-rater consistency. Taking into account the results from the three methods and the consensus assessment by psychiatric doctors, we have reason to believe that item 6, item 7, item 8, item 12, item 13, and item 14 are the core items of the ASRS.

In the first round of administration, the researcher spoke with participants and received feedback that the content items were long and difficult to understand. An additional 10 psychiatrists were invited to participate in a focus group to discuss the ASRS and ASRS-CSV based on the DSM-5 diagnostic criteria. The vast majority of physicians felt that the scale items were too long and that individual words were difficult to understand. This may result in individuals with higher ADHD traits having difficulty fully comprehending the content of the items, thus affecting the results of the assessment. It was suggested that the number and length of items should be simplified as much as possible and replaced with simple and consistent text. However, several physicians disagreed. They felt that the original version of the scale should still be respected. Therefore, based on the above, we attempted to revise and rewrite the core entries of the simplified Chinese version. The ASRS-CSVN was generated, and 10 independent psychiatrists were invited to evaluate the consistency of the scale with the diagnostic criteria (Table 5). 10 psychiatrists agreed that the ASRS-CSVN

had good consistency with diagnostic criteria, was easier to understand, and was suitable for use in a sample of Chinese adults. The Fleiss 'Kappa (0.84), and Krippendorff's alpha values (0.91) all indicate that the current round of expert consultation has yielded favorable inter-rater consistency.

Table 5 Comparison between DSM-5, ASRS-CSV, ASRS-CSVN

	DSM-5	ASRS-CSV	ASRS-CSVN
Inattention	A1f 经常回避，厌恶或不情愿从事那些需要精神上持续努力的任务。	当有一件需要多费心思考的工作时，你会多常逃避或是延后开始去做？	我会拖延或者回避棘手的任务。
	A1g 经常丢失任务或活动所需的物品	在家里或是在工作时，你会多常没有把东西放对地方或是找不到东西？	我在生活中记错或找不到东西。
	A1h 经常容易被外界的刺激分神	你会多常因身旁的活动或声音而分心？	我会被无关的事情分散注意力。
Hyperactivity -Impulsivity	A2c 经常在不适当的场所坐立不安	你会多常觉得静不下来或烦躁不安？	我感到不安或烦躁。
	A2d 经常无法安静的玩耍或从事休闲活动	当有自己独处的时间时，你会多常觉得有困难使自己平静和放松？	我感到紧绷和难以放松。
	A2e 经常“忙个不停”，好像被“发动机驱动着”	你会多常像被马达所驱动一样，觉得自己过度地活跃，不得不做事情？	我感觉自己过度活跃，像打了鸡血一样。

Note: Chinese was used in the testing of the scale, which has been translated into English for the convenience of the subjects. (See appendix for Chinese).

Psychometric test of ASRS-CSVN

From the perspective of reliability index, Cronbach's α coefficients of each sub-scale and total scale were 0.72, 0.68 and 0.81, respectively. From the validity index, the AVE value of Inattention factor was 0.501, and the AVE value of hyperactivity-impulse factor was 0.502, indicating that the scale had strong convergence validity. The HTMT value of ASRS-CSVN is 0.861. The other fitting indexes are as follows: CFI is 0.99, TLI is 0.97, GFI is 0.99, RMSEA is 0.05, SRMR is 0.02. In the calibration association validity, ASRS-CSVN has a high correlation coefficient with PHQ-2 and GAD-2 ($r=0.36$-0.64, $p < 0.001$), with high external consistency. In conclusion, ASRS-CSVN has excellent reliability and validity and can

be used for self-assessment screening of ADHD in Chinese adults or adolescents.

The diagnostic cutoff of the ASRS-CSV

We used RStudio (version 2022.12.0) to analyses ROC. As shown in Figure 3, Figure 4 which employing an ASRS threshold of ≥ 16 as a reference point, The ASRS-CSV shows high diagnostic efficacy for Attention Deficit (AD) with AUC values of 0.938 in males and 0.933 in females, and for Hyperactivity Disorder (HD) with AUCs of 0.972 in males and 0.958 in females. The sensitivity and specificity of the ASRS-CSV, as detailed in the Table 6, indicate that, based on the Youden index, a score of 5 or 6 on the ASRS-CSV is an appropriate diagnostic cutoff.

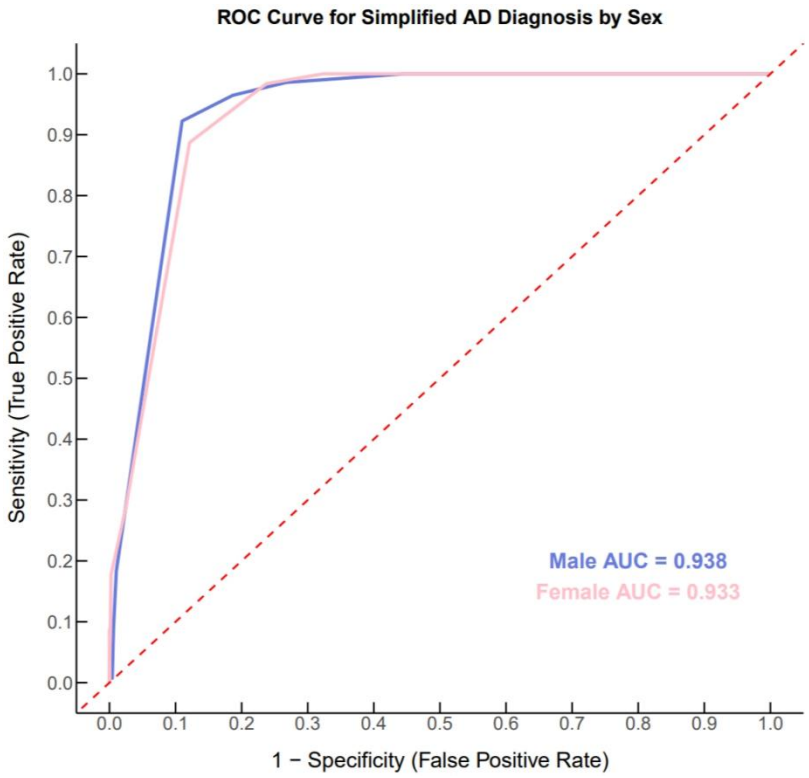


Figure 3 The ROC Curve for Simplified AD Diagnosis by Sex

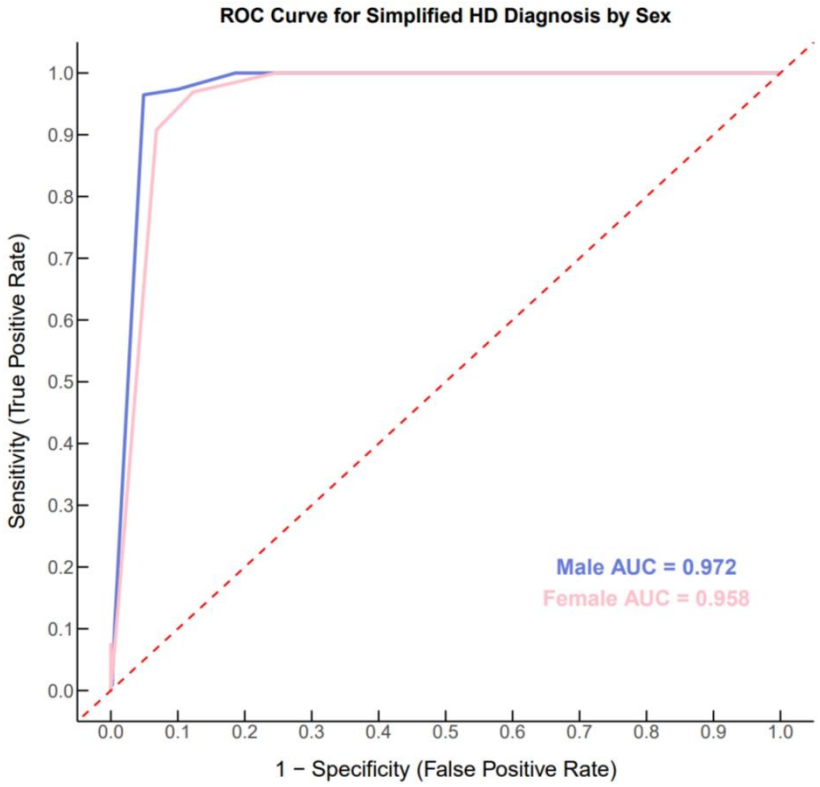


Figure 4 The ROC Curve for Simplified HD Diagnosis by Sex

Table 6 Sensitivity and specificity of the ASRS-CSV

	male				female			
	Cutoff	Sensitivity	Specificity	YI	Cutoff	Sensitivity	Specificity	YI
AD	1.00	1.00	0.44	0.44	1.00	1.00	0.29	0.29
	2.00	1.00	0.49	0.49	2.00	1.00	0.35	0.35
	3.00	1.00	0.55	0.55	3.00	1.00	0.44	0.44
	4.00	0.99	0.73	0.72	4.00	1.00	0.68	0.68
	5.00	0.96	0.81	0.78	5.00	0.98	0.76	0.75
	6.00	**0.92**	**0.89**	**0.81**	**6.00**	**0.89**	**0.88**	**0.77**
	7.00	0.18	0.99	0.17	7.00	0.29	0.97	0.27
	8.00	0.09	0.99	0.09	8.00	0.18	1.00	0.17
	9.00	0.06	1.00	0.06	9.00	0.09	1.00	0.09
	10.00	0.01	1.00	0.01	10.00	0.01	1.00	0.01
HD	1.00	1.00	0.49	0.49	1.00	1.00	0.33	0.33
	2.00	1.00	0.56	0.56	2.00	1.00	0.42	0.42
	3.00	1.00	0.64	0.64	3.00	1.00	0.52	0.52
	4.00	1.00	0.81	0.81	4.00	1.00	0.75	0.75
	5.00	0.97	0.90	0.87	**5.00**	**0.97**	**0.88**	**0.85**
	6.00	**0.96**	**0.95**	**0.92**	6.00	0.91	0.93	0.84
	7.00	0.11	0.99	0.10	7.00	0.14	0.99	0.13

8.00	0.02	1.00	0.02	8.00	0.08	1.00	0.08
9.00	0.01	1.00	0.01	9.00	0.02	1.00	0.02
10.00	0.01	1.00	0.01	10.00	0.02	1.00	0.02

Note. YI Yonden index. The cutoff values corresponding to the maximized Youden index are bold

Discussion

We used intergroup variance analysis, factor analysis, and network analysis to study the core symptoms of ADHD using Chinese population samples, and generated a simplified version of ASRS. We propose that item 6, item 7, item 8, item 12, item 13, and item 14 are the core items of the ASRS. We recommend an appropriate diagnostic threshold of 5 or 6 points. The revised ASRS-CSV & ASRS-CSVN scales have good reliability and validity, they can be used as the reliable and valid assessment tools to screen and aid in the diagnosis of ADHD symptoms in Chinese populations.

In this study, the Chinese version of the ASRS scale was revised in more detail and two versions of the ASRS-CSV & ASRS-CSVN were developed to provide a simplified version of the Chinese measurement tool for large-scale ADHD screening. Furthermore, this study also reveals cross-cultural disparities in the core items compared to existing research. In the WHO-provided ASRS-6 version, the core ADHD symptoms exhibited by the American sample include "Does not follow through," "Difficulty organizing," "Avoids effort," "Forgetful," "Fidgeting," and "On the go," with two symptoms overlapping with this study's findings (Kessler et al., 2005).In Japan, a culture within the same East Asian region as China, researchers identified core ADHD items as "Careless mistakes," "Loses things", "Does not follow through", "Difficulty organizing " ,"Rules conversation one-sidedly " and "Forgetful" only one item coinciding with the present study's results (Takeda et al., 2017). It is hypothesized that ADHD, as a neurodevelopmental disorder, may be closely associated with the cultural environment in which patients find themselves(Timimi and Timimi, 2015). Different cultures have varying expectations regarding adaptive behaviors and attention levels. Variations in cultural values and educational systems in China, the United States, and Japan are likely to influence the expression of ADHD symptoms. Therefore, we recommend that when promoting a shortened version of the

ASRS, cultural specificity should be carefully considered, and cross-cultural invariance testing should be conducted.

From the perspective of methodological robustness, this study employed three different methods to cross-validate the core symptoms of ADHD. Intergroup difference analysis, factor analysis, and network analysis represent three common approaches for simplifying scales and analyzing data, each offering unique advantages. Intergroup difference analysis allows researchers to swiftly identify which symptoms exhibit significant disparities among different groups, offering a straightforward and intuitive tool(Takeda et al., 2017). Factor analysis unveils the underlying structure of symptoms, grouping related symptoms into factors, thereby simplifying data and enhancing interpretability(Williams et al., 2010). Network analysis, on the other hand, permits the exploration of the complexity of the disorder, capturing the interrelationships among symptoms, and facilitating personalized treatment strategies. Network centrality reveals the pivotal role of specific symptoms(Bringmann et al., 2019).The synergistic application of these methods holds substantial significance as it provides a more comprehensive understanding and yields deeper, insightful results. It underscores the robustness of the core symptoms within this study's sample and their consistency across different methods.

In summary, this study provides two versions of the simplified version of the ASRS scale for conducting ADHD screening. The first version (ASRS-CSV) is based on the reduced entries of the original scale, which is more concise and accurate in content while meeting the DSM-5 diagnostic criteria. The second version (ASRS-CSVN) is a simplified version of the scale in which the text is further reduced without changing the original meaning of the content so that adolescents and those who may have reading difficulties can better understand the content of the scale. The two versions of the items have the same content and are applicable to different scenarios, giving researchers flexibility to choose according to research subjects and regions.

Limitations and prospects

While this study delves into the core symptoms of ADHD within the Chinese

population, it is imperative to candidly acknowledge the significant limitations that may impact the interpretation and generalizability of our findings. Firstly, the reliance on a cross-sectional sample limits our observations to a specific point in time. Longitudinal research would provide a more comprehensive understanding of the development and changes in ADHD symptoms, as well as the stability of core symptoms. Hence, we encourage future studies to consider adopting a longitudinal design to assess the characteristics of ADHD symptoms more comprehensively.

Secondly, the issue of sample representativeness is of paramount importance for the generalizability of research findings. This study utilized a specific sample, potentially restricting its representativeness. Future research should contemplate expanding sample size and diversity to better encapsulate various segments of the Chinese population and validate the results of this study.

Lastly, it is vital to recognize the limitations of the three methods employed. Each method possesses its unique advantages and limitations and may not comprehensively capture all aspects of ADHD. Future research could explore a combination of methods, such as Item Response Theory (IRT), to gain a deeper understanding of the multifaceted nature of ADHD.

In summary, despite the limitations including the cross-sectional design, sample representativeness, and the use of self-report data, this study offers valuable insights into the core symptoms of ADHD within the Chinese population. These limitations, however, provide a constructive path for future research to delve deeper into ADHD and offer substantial support for enhancing clinical diagnosis and interventions.

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